

Anthropogenic aerosols and the weakening of the South Asian summer monsoon

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Abstract

As an integral component of the Earth's hydrological cycle, the South Asian summer monsoon is critical for the well-being of over one-fifth of the world's population. Observations show that South Asia underwent a widespread drying during the second half of the twentieth century, but it is still largely unclear whether this prolonged shift was due to natural variations or human activities. Here we use a series of perturbation experiments with a state-of-the-art climate model, which realistically simulates the observed historical trend when driven with all known climate forcings, to investigate the South Asian monsoon response to natural and anthropogenic factors, with particular focus on aerosols and greenhouse gases. We find that the observed precipitation decrease is very likely to be of anthropogenic origin, and can be attributed almost entirely to aerosols. The drying is a robust outcome of a slowdown of the tropical meridional overturning circulation, which is fundamentally driven by the need to counteract the aerosol-induced energy imbalance between the northern and southern hemispheres. In contrast, greenhouse gases give rise primarily to a weakening of the equatorial zonal overturning circulation. These results provide compelling evidence of the prominent role of aerosols in shaping regional climate change over South Asia.